The Mathematics of Coupled Oscillator Arrays

Ronald J. Pogorzelski
Jet Propulsion Laboratory

Abstract

Phased array antennas are desirable for planetary exploration communications applications because they can provide agile high gain beams which can be steered at electronic speeds. They are typically complicated, massive, and expensive and these attributes have deterred projects from using them regardless of their desirable qualities. Recently, a new method of generating the aperture phase distributions needed for phased arrays was proposed by York and collaborators at UCSB. JPL has pursued this concept and built several arrays with beam steering capabilities based on this new method. The method involves the used of arrays of electronic oscillators in a nearest neighbor coupling scheme resulting in mutual injection locking. The array of oscillators oscillates as an ensemble and provides signals properly phased for excitation of the elements of a phased array antenna in such a manner as to produce an electronically steerable beam.

The oscillator arrays described above were typically analyzed by means of a system of simultaneous non-linear differential equations solved numerically. However, it has been shown that the problem may be linearized and reformulated as a single linear partial differential equation which, while only approximately representing the behavior of the array, can be solved analytically to provide considerable insight in to the behavior of such arrays. This presentation describes this formulation and displays several example solutions. A number of properties of the arrays can be deduced from these results and these will be summarized in the presentation. The description will primarily deal with one dimensional (linear) arrays but available two dimensional results will also be outlined.

Related Clearances:

CL 98-0430
CL 98-0909
CL 99-0001
CL 99-0038
CL 99-0873
CL 99-1631
CL 00-0528
CL 00-0529
CL 00-1580

CL 99-0859